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Feasibility Study of Resource Recovery Opportunities for Hawkins County, Tennessee

CSI Resource Systems, Inc.
Boston, MA

Prepared for

Environmental Protection Agency
Atlanta, GA

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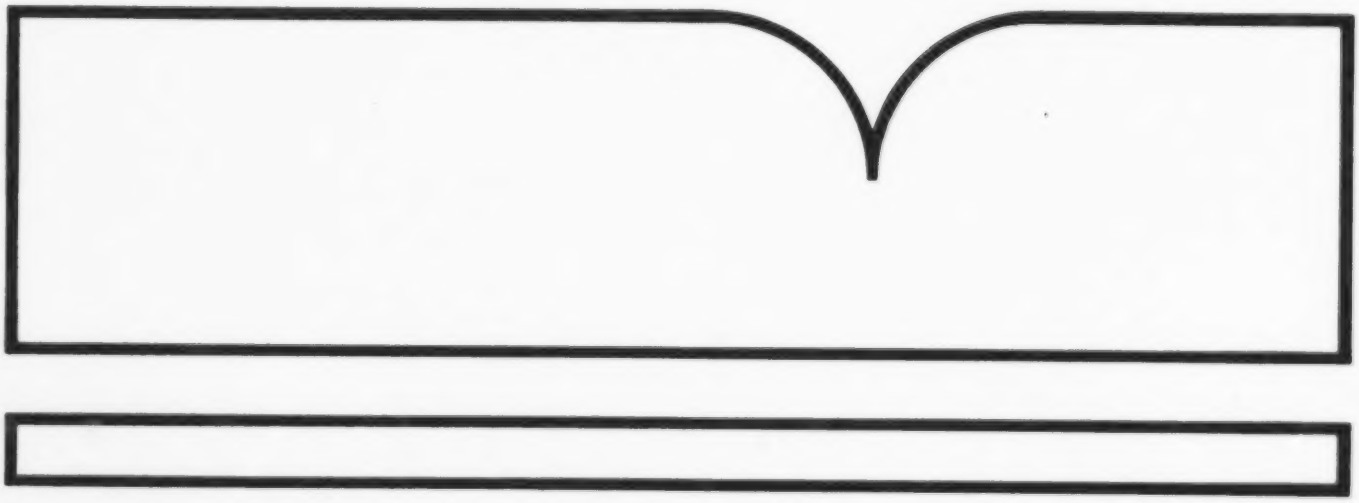

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This report presents the results of a preliminary determination of the feasibility of resource recovery for the County. This determination involved an evaluation of the market potential for energy recovery from solid waste, the development and evaluation of resource recovery alternatives, and the identification of major tasks to be performed prior to deciding to implement a resource recovery project. These activities reflect the results of two site visits to Hawkins County and discussions with County and municipal personnel along with two industrial energy users in the area.

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A TECHNICAL ASSISTANCE PROGRAM REPORT

FEASIBILITY STUDY OF RESOURCE RECOVERY OPPORTUNITIES FOR HAWKINS COUNTY, TENNESSEE

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RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

U. S. ENVIRONMENTAL PROTECTION AGENCY
TECHNICAL ASSISTANCE PROGRAM REPORT SERIES

PRELIMINARY FEASIBILITY STUDY OF RESOURCE RECOVERY OPPORTUNITIES FOR HAWKINS COUNTY, TENNESSEE

PREPARED FOR
OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION IV

BY

CSI RESOURCE SYSTEMS, INC.

NOVEMBER 1980

PREFACE

This report was prepared for Hawkins County, Tennessee, under the Technical Assistance and Panels Program, which is conducted by the U.S. Environmental Protection Agency (EPA) to provide assistance to state and local governments. Technical assistance was provided in response to a request submitted to U.S. EPA Region IV by Hawkins County.

This report presents the results of a preliminary determination of the feasibility of resource recovery for the county. This determination involved an evaluation of the market potential for energy recovery from solid wastes; the development and evaluation of resource recovery alternatives; and the identification of the major tasks to be performed prior to deciding to implement a resource recovery project. These activities reflect the results of two site visits to Hawkins County by CSI Resource Systems, Inc. (Resource Systems); and discussions with county and municipal personnel and two industrial energy users in the area.

Resource Systems is a technical assistance contractor to the Office of Solid and Hazardous Waste, U.S. EPA Region IV. Under the terms of the Technical Assistance and Panels Program, all of Resource Systems' technical assistance activities on behalf of Hawkins County were paid for by EPA.

Resource Systems wishes to thank especially the following individuals for their support and generous cooperation: Ben Scott, Plant Engineer, Holliston Mills; Frank Testerman, Solid Waste Committee Member, Hawkins County Commission; and Frank Victory, State of Tennessee Department of Public Health, Division of Solid Waste Management.

TABLE OF CONTENTS

CHAPTER 1. OVERVIEW 1

Findings/Conclusions 3

Immediate Next Steps 6

CHAPTER 2. SOLID WASTE COLLECTION, DISPOSAL, AND GENERATION 9

Current Collection and Disposal Practices 9

Current Waste Generation 10

Projected New Landfill Costs 11

CHAPTER 3. RESOURCE RECOVERY OPTIONS 13

Resource Recovery Using Hawkins County Waste Only 14

Resource Recovery Augmented by 30 to 40 TPD_5 from a Neighboring County 23

Resource Recovery Outside of Hawkins County..... 25

CHAPTER 4. IMMEDIATE NEXT STEPS 27

Implement Resource Recovery 27

Continue Reliance on Landfilling 31

APPENDIX A. STATE OF TENNESSEE RESOURCE AND ENERGY FACILITY PROGRAM

APPENDIX B. ECONOMIC AND FINANCING ASSUMPTIONS AND PROJECTIONS

CHAPTER 1. OVERVIEW

Hawkins County, an area of some 41,000 people, is located in northeastern Tennessee, just south of the Virginia border. The county encompasses five incorporated areas, the largest of which is the city of Rogersville (population around 4,500); the remainder of the county is primarily rural. As the one existing county landfill has reached its capacity limits, the county must secure a new landfill site. Recognizing that a new landfill will mean an increase in both the cost of collection (because of longer haul distances) and the cost of disposal (because of land acquisition and preparation costs and the costs of complying with more stringent environmental requirements), the county wished to consider resource recovery options, in particular, energy recovery, as a means of minimizing future disposal costs and of extending the life of the required new landfill. Consequently, the county requested technical assistance from the U.S. Environmental Protection Agency (EPA) to evaluate resource recovery as a solid waste disposal option.

The prefeasibility study had two overall objectives: first, to determine, on a preliminary basis, whether or not any potentially viable market/waste supply matches exist that would warrant technical and economic consideration; and second, if the findings are positive, to identify those immediate steps that should be performed prior to a commitment of significant additional resources for a comprehensive feasibility study.

The feasibility of resource recovery depends on the presence of five basic ingredients for a successful project. These are:

- Potentially viable energy buyers whose requirements would use all or most of the usable, or processible, solid waste generated.*
- A sufficient tonnage of processible solid waste from which enough energy and/or marketable materials could be produced to meet the requirements of one or more potentially viable buyers.

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* Processible solid waste is that tonnage of the total waste potentially available which could be processed in a resource recovery facility. Unprocessible materials include oversized, bulky waste (e.g., large metal objects, bed springs, rugs) and white goods.

- Potentially available sites that are well situated with respect to the shipment of solid waste and the delivery of energy to prospective buyers.
- Commercially available technologies that can be used to meet the energy requirements of the identified markets.
- A total disposal cost that is competitive with the alternative disposal methods available to participating communities.

To assist Hawkins County in establishing the preliminary feasibility of resource recovery, the study initially focused on a review of the existing waste disposal system in order to develop a preliminary estimate of the amount of waste available for processing in a resource recovery facility. The results of this effort indicated that the estimated tonnage available in Hawkins County alone for processing in a resource recovery system may be insufficient to support an economically competitive facility.

While it appeared that the estimated available tonnage might be too low to support an economically competitive resource recovery facility, because the county is faced with a critical waste disposal problem, the feasibility of processing this estimated tonnage was analyzed. In addition, the study included an assessment of resource recovery possibilities where Hawkins County waste would be augmented by waste from a neighboring county.

In the remainder of this chapter, the study findings and conconclusions are summarized, and immediate next steps are identified. Chapters 2 and 3 present the study findings in more detail. In Chapter 4, the immediate next steps that are critical to Hawkins County finding a solution for its imminent waste disposal problem are discussed. Appendix A contains a discussion of the requirements of the State of Tennessee Resource and Energy Facility Loan Program -- a possible source of financing for a resource recovery project serving Hawkins County. Appendix B gives the assumptions used in and the findings of the preliminary economic analysis.

FINDINGS/CONCLUSIONS

The findings of this preliminary feasibility study indicate that resource recovery could be a viable option for Hawkins County under the following conditions: (1) the county is able to augment its estimated tonnage of processible waste with additional tonnage from a neighboring county; (2) Holliston Mills (the one potential energy buyer located in Hawkins County) adds a third shift to achieve 24-hour operations; (3) funding from the Tennessee Valley Authority (TVA) is available; and (4) financing is obtained from the State of Tennessee Resource and Energy Facility Loan Program. This conclusion is based on the following:

- Hawkins County faces an imminent disposal problem as the capacity of the existing county landfill is exhausted, and the county is under mandate by the State Department of Public Health to develop a new sanitary landfill. Disposal costs at a new landfill are likely to be close to $12 per ton by 1983.[1]

- On the basis of two recent solid waste studies, Hawkins County appears to generate between 68 and 78 TPD_5 (tons per day on a 5-day-per-week basis) of waste. Of this amount, some 54 to 62 TPD_5 is assumed to be available for processing in a resource recovery facility.

- Only one potential buyer of waste-derived energy exists in the county -- Holliston Mills -- whose energy requirements are sufficient to utilize substantial portions of the energy contained in the estimated processible tonnage potentially available; and whose current energy use (natural gas) is compatible with the objective of displacing high-cost fuels. However, a major constraint to a resource recovery project servicing Holliston Mills is the fact that the company's energy demand is currently limited to 12 to 16 hours per day, which would result in a low system load factor. If a sufficient incentive (i.e., third-shift energy priced at a substantial discount) were offered to Holliston, the company has indicated that it would consider increasing its operations to 24 hours per day.

- Holliston Mills-owned land contiguous to the manufacturing plant could be available to site a resource recovery facility.

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1. Landfill disposal cost projections derived from cost estimates contained in "Structural Organization of the Hawkins County Sanitation Department," County Technical Assistance Service, fall 1979.

- A modular combustion unit (MCU) system with a design capacity of 72 TPD and an annual average throughput of about 62 TPD_5 of solid waste could be used to produce either steam or high-temperature gas for sale to Holliston.* However, even under the most optimistic assumptions (including 24-hour-per-day, 5-day-per-week operations at Holliston Mills), such a plant does not appear to be economically competitive with the cost of continued primary reliance on landfilling:

  - Even assuming the availability of TVA grant monies and lower interest State of Tennessee financing under the Resource and Energy Facility Loan Program, the net disposal cost at the resource recovery facility alone is projected to be around $23 per ton in mid-1983** and $21 per ton in mid-1988.

  - Because the county will still need to develop a new landfill to dispose of what could amount to as much as 35 percent (by weight) of the waste stream (comprising unprocessibles, process residues, and emergency bypass waste***), the costs of resource recovery, to some extent, will be incremental to the costs of landfilling. Consequently, for a resource recovery facility to be considered an economically viable solid waste management option for the county, it should be competitive with the costs of a new sanitary landfill designed to process all of the waste generated in Hawkins County.

- A 90-TPD_5 (design capacity of 100 TPD) MCU-based system using Hawkins County waste and augmented by 30 to 40 TPD_5 of waste from a neighboring county appears to be economically competitive with continued primary reliance on landfilling. This facility would produce either steam or high-temperature gas for sale to Holliston Mills, which, again, would operate on an expanded 24-hour-per day, 5-day-per-week basis. The net disposal cost at the resource recovery facility (assuming that TVA funding and lower interest financing under the state program are obtained) is

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* Design capacity is the manufacturer's rated capacity of the waste processing equipment. Annual average throughput is the amount of waste processed by the system on a 5-day-per-week basis averaged throughout the year.

** The beginning of the assumed first year of commercial operations.

*** Bypassed waste is that portion of the processible tonnage that goes directly to the landfill in the event that the resource recovery system is either on scheduled or forced outage.

projected to be around $11 per ton of waste in mid-1983. By mid-1988, a cost of $5 per ton is projected. It should be noted that these net disposal costs were estimated assuming that Holliston Mills would expand to 24-hour-per-day operations in response to third-shift energy priced at a 25-percent discount. If such a discount were found to be an insufficient incentive and a larger discount (i.e., 50 percent) were required, net disposal costs at the resource recovery facility would likely increase by some $5 per ton. On the other hand, economics are likely to be improved if a larger-size facility could be implemented (e.g., a facility with a throughput capacity of 108 TPD_5), with a 25-percent discount for third-shift energy.

A resource recovery system to provide either steam or high-temperature gas to Holliston Mills compares favorably with continued primary reliance on landfilling in several respects:

- The county would probably save on land disposal costs by handling less waste at the landfill.
- The life of the new sanitary landfill could be extended by as much as 4 times its initial projected useful life (depending on the tonnage of waste that that was imported from the neighboring county).
- Holliston Mills would gain a cost-competitive and secure locally produced alternative energy source compared to its current reliance on natural gas.
- The county would be contributing to the achievement of national alternative energy goals.
- A modular-based system affords the county the option to increase the capacity (and, hence, output) of the resource recovery facility in future years in response to increased waste generation and/or industrial development. The availability of this alternative energy source could be a means of attracting new industry.
- A resource recovery facility itself would create additional industrial-sector jobs.
- Resource recovery is an environmentally sound method of solid waste management. By processing the majority of its waste in a resource recovery facility, the county would reduce the chance of groundwater pollution from a landfill.

If Hawkins County and Holliston Mills cannot meet the several conditions necessary for a viable in-county resource recovery project,

it may be feasible for the county to implement a joint resource recovery project to be located in a neighboring county and to service an energy buyer(s) in that county. Investigation of this option was, however, beyond the scope of this prefeasibility study.

IMMEDIATE NEXT STEPS

The findings and conclusions summarized above are conditional and preliminary indications of project feasibility; further investigation is necessary to determine if resource recovery is the preferred waste management option, and whether, in fact, a project can be implemented. Several critical tasks must be performed to verify the preliminary findings, before committing substantial resources to project implementation. As the eligibility requirements under the State of Tennessee Resource and Energy Facility Loan Program would necessitate submittal of a project prefeasibility study by January 15, 1981, in order to be eligible to receive financing in that year, the country would have to move quickly. The critical next steps are:

- Hold discussions with Holliston Mills to ascertain its level of interest in a resource recovery project, particularly as regards its willingness to consider operating 24 hours per day in response to third-shift energy offered at a substantial discount. Obtain more detailed information on the company's energy practices and requirements, including detailed energy load profiles showing hourly, daily, and seasonal variations; aggregate current and projected fuel costs; and electrical, water, and other utility charges.

- Establish a waste characterization program in Hawkins County to ascertain that a sufficient amount of solid waste with a sufficient energy value is available to satisfy the requirements of the potential energy customer. In addition, determine the seasonal fluctuations in waste quantity and composition.

- In parallel with obtaining a more reliable estimate of the processible tonnage generated in Hawkins County, establish the feasibility of securing additional tonnage from a neighboring county such that a waste processing capacity of 90 TPD_5 or greater could be achieved.

- Determine whether Hawkins County and the participating neighboring county control the various portions of the waste stream generated within the respective counties; develop strategies to ensure that the waste can be directed to a resource recovery facility.

If these tasks confirm the feasibility of a Hawkins County project, a prefeasibility study should be submitted to the State of Tennessee as part of an application under the Tennessee Resource and Energy Facility Loan Program. In addition, as the economic feasibility of this project appears to be dependent upon the receipt of the previously committed TVA financing, the county would have to obtain a firm commitment for this financing prior to applying for a state grant.

If the county is interested in pursuing the concept of joint participation in a resource recovery facility to be located elsewhere, concurrent to the above-mentioned steps, it should hold discussions with neighboring counties to ascertain their interest in a possible joint project to be located in their county and to service a local energy buyer(s). A feasibility investigation of such a project would involve identifying an economically viable match among waste generation, energy market(s), sites, and available technologies, similar to the investigation reported here.

In considering resource recovery (whether it be an in-county project or a joint project located in a neighboring county), Hawkins County should be aware that:

- Even if resource recovery is implemented, a substantial portion of the solid waste stream will still require ultimate landfill disposal. This portion may be as high as 35 percent on a tonnage basis (but about 25 percent on a volume basis, which is the critical measure for determining landfill requirements). This waste includes oversized, bulky materials and noncombustibles that are diverted from the project; residues of combustion; and emergency bypass waste.

- Whether resource recovery is implemented or not, the new county landfill must be in compliance with stringent environmental requirements.

- Development of an MCU system normally requires at least 24 months after procurement contracts are

executed. This lead time suggests mid-1983 as the earliest date for a fully operational system.

Should the county decide not to pursue resource recovery, it can investigate the possibility of hauling its waste to a neighboring county for disposal in that county's landfill(s), in lieu of developing a new Hawkins County landfill. Investigation of this option was not, however, within the scope of this study.

CHAPTER 2.
SOLID WASTE COLLECTION, DISPOSAL, AND GENERATION

The attractiveness and feasibility of resource recovery for Hawkins County depends in part on the magnitude of the county's solid waste disposal problem, the amount of waste that is potentially available for processing, and the economics of resource recovery as compared with continued primary reliance on landfilling. The capacity of the one existing county landfill is exhausted, and Hawkins County is under mandate from the Tennessee State Department of Public Health to secure and develop a new landfill disposal facility. As the county has been unable to overcome citizen opposition to siting a new landfill, it now faces a critical disposal problem. Even if the county implements a resource recovery facility, it still must develop a new disposal site to receive all of the county's waste in the short term and bypassed waste, unprocessibles, and process residues in the long term.

Information on the county's waste collection and disposal practices and waste generation was obtained during two site visits and from a review of several recent solid waste studies. The primary findings of the site visits and this review are that the county only generates 54 to 62 TPD_5 of processible waste and that landfill disposal costs for a new landfill are projected to be approximately $9 per ton in 1980. In 1983, these costs could reach $12 per ton.

In the remainder of this chapter, current solid waste collection and disposal practices in Hawkins County are described; waste generation is estimated, and an estimate of the disposal cost at a new landfill is given.

CURRENT COLLECTION AND DISPOSAL PRACTICES

With the exception of Bulls Gap, each of the five incorporated areas in Hawkins County has a municipally operated collection system. In Bulls Gap, the municipality contracts for services with private collectors, and residential and commercial waste pickups occur once

a week. The other four municipalities provide residential collection once a week, and commercial collection services twice a week. The remainder of the county is serviced by a county-operated greenbox system with pickup typically twice a week. Collection service costs in the county are paid for from the taxes of the respective communities.

All of the solid waste collected in the county is currently disposed of at the Hawkins County landfill, which is located just south of Rogersville. This landfill has reached its capacity, and the county is under mandate from the Tennessee State Department of Public Health to secure a new landfill site. Of the sites currently under consideration, the most attractive is about 7 miles south of Rogersville (representing an additional haul distance of about 5 miles relative to the location of the existing landfill).

Current collection and disposal cost data are not available. The Hawkins County Highway Department is responsible for operating the existing landfill, as well as for maintaining county roads. The Highway Department does not maintain separate records on the cost of operating the landfill. No disposal charge is currently levied for solid waste disposal at the county landfill.

CURRENT WASTE GENERATION

A review of two recent solid waste studies indicates that Hawkins County generates an estimated 68 to 78 TPD_5 of waste. A 1978 solid waste study undertaken by the First Tennessee-Virginia Development District (FT-VDD) projected that an estimated 19,500 tons of solid waste would be delivered to Hawkins County landfill in FY 1980, or approximately 78 TPD_5.[1] A recent TVA study indicated that some 17,000 tons per year, or 68 TPD_5, are generated.[2] On the basis of waste composition work previously performed in other regions of the county, a conservative estimate of 20 percent of this waste stream was assumed to be unprocessible,

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1. FT-VDD Solid Waste Survey, 1979.
2. Five County Eastern Tennessee Solid Waste Management Study, Tenressee Valley Authority, 1978.

leaving an estimated 54 to 62 TPD_5 of waste potentially available for processing in a resource recovery facility. For purposes of this prefeasibility study, the higher estimate (62 TPD_5) was assumed in order to assess the potential for resource recovery under the most favorable conditions.* Because the basis for developing both the FT-VDD and TVA estimates of annual tonnage is not known, the 62-TPD_5 estimate should be considered as very preliminary. While an estimate of this nature is appropriate at the prefeasibility level, were a decision made to proceed with a project to serve Hawkins County, the estimate would have to be verified and account for the impact of such factors as seasonal variations in waste generation and composition, and increases in future waste generation as a result of increased per-capita generation rates, population growth, and industrial development.

The energy content (higher heating value) of the waste was assumed to be 4,500 British thermal units (Btu) per pound on the basis of waste quality data obtained from other primarily rural regions of the country.

PROJECTED NEW LANDFILL COSTS

Because acquisition of a new landfill has not yet begun in Hawkins County and because accurate cost data for the existing landfill are not available, it was not possible to develop a site-specific disposal cost estimate for a new county landfill. However, a recent engineering study performed for Hawkins County indicates that a per-ton disposal charge of around $9 would be necessary in 1980 for a new county landfill to be economically self-supporting.[3] Assuming a 10-percent annual escalation in the cost of operating a sanitary landfill, by 1983, the net disposal charge would be close to $12 per ton.

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* Because waste composition data were not available for Hawkins County, it may be an understatement to assume that 20 percent of the waste is unprocessible.

3. Op. cit., County Technical Assistance Service, fall 1979.

If Hawkins County implements resource recovery in the county, a landfill is a necessary component of the resource recovery system. Consequently, the costs of resource recovery cannot be considered as a direct substitute for the costs of developing and operating a new solid waste sanitary landfill. While resource recovery could reduce the volume of waste to be landfilled by as much as 75 percent, the landfill still must be available to dispose of the remaining portion of the waste stream, comprising unprocessibles, process residues, and emergency bypass waste. In other words, although a technically and economically feasible resource recovery project serving Hawkins County could result in reduced landfill disposal costs, to some extent, the cost of a resource recovery facility will be incremental to the cost of a new landfill.

CHAPTER 3.
RESOURCE RECOVERY OPTIONS

Although it was questionable whether the estimated 62 TPD_5 of processible waste available in the county could support an economically competitive resource recovery facility, the technical and economic feasibility of a facility sized to process this amount of waste was assessed because the county does face an imminent waste disposal problem. The results of this assessment indicated that a resource recovery facility processing Hawking County waste only to provide steam or high-temperature gas to Holliston Mills (the only potential energy buyer identified in Hawkins County) does not appear to be economically competitive when compared to the estimated cost of new landfill designed to dispose of all of the county's solid waste.

Because of the critical problem facing the county and because of the problems encountered thus far in securing a new landfill site, another resource recovery option was investigated to determine, on a preliminary basis, its feasibility for Hawkins County. This latter option is to implement a resource recovery facility in Hawkins County that would be augmented by at least 30 to 40 TPD_5 of processible waste from a neighboring county, such that the total waste processing capacity would be around 90 TPD_5 and the design capacity, 100 TPD. This plant would service Holliston Mills operating on a 24-hour-per-day basis, 5 days a week.

The market, technical, and economic analyses indicated that an MCU-based 90-TPD_5 resource recovery facility supplemented by at least 30 TPD_5 of waste from a neighboring county could be economically viable if a number of conditions could be met. The scenario under which this option could be feasible is discussed in this chapter; the immediate next steps that should be conducted if the county wishes to pursue this option are discussed in Chapter 4.

While it was not within the scope of this study to evaluate the possibility of a joint resource recovery project between Hawkins County and a neighboring county where Hawkins would haul its waste to a recovery

facility located in the other county and servicing a local energy buyer(s), Hawkins County should consider this approach as another possible option to continued primary reliance on landfill disposal. A brief description of this option is included in this chapter; in Chapter 4, the immediate next steps to be taken by the county. should it decide to pursue this approach, are presented.

Obviously, if the county should decide not to pursue resource recovery, it can continue its reliance on landfilling as the primary means of solid waste disposal. Because of the difficulty encountered thus far in securing a new landfill site within the county, if landfill disposal is the preferred waste management approach, Hawkins may want to consider investigating opportunities for using a landfill(s) located in a neighboring county. Again, it was beyond the scope of the study to evaluate options for landfill disposal outside of Hawkins County. However, this approach to solid waste management is discussed in terms of associated immediate next steps in Chapter 4.

In the remainder of this chapter, the findings and conclusions relative to the various resource recovery options assessed are presented.

RESOURCE RECOVERY USING HAWKINS COUNTY WASTE ONLY

Once an estimate of waste generation in the county was obtained, it was necessary to investigate whether or not there was a viable match among the county's waste supply, market requirements, sites, and available technologies. Consequently, a preliminary energy market/site survey was conducted, followed by a technical and economic analysis of project opportunities. The results of these tasks are summarized below.

Energy Market/Site Survey

Information obtained from the Hawkins County Commission indicated that only two possible energy markets exist in the county -- Holliston Mills, a textile concern; and the Holsten Army Ammunition Plant (HAAP). Holliston Mills would purchase either steam or high-temperature gas; HAAP would purchase low-pressure steam.

For purposes of waste-derived steam, the most desirable steam customers require low-pressure and low-temperature steam, have a constant steam demand on a 24-hour-per-day basis and a minimum of 5 days per week throughout the year, and currently use high-priced fuels in their boilers. This latter characteristic is desired because the price that can be obtained for the waste-derived energy is dependent on the price of the fuel that it displaces. A desirable customer of waste-derived gas has similar characteristics, except that the steam conditions are not applicable in this case. For both types of customers, a potentially available site should exist nearby where a resource recovery facility could be located, and the customers should be located close to the centroid of the wasteshed to minimize haul costs. For a high-temperature gas customer, the resource recovery facility must be much closer to the plant it is serving.

On the basis of these desired characteristics, the preliminary market survey indicated that Holliston Mills could be considered a viable energy customer for steam or high-temperature gas, only if the company were to increase its operations to 24 hours per day. HAAP was eliminated as a potentially viable energy customer because the amount of steam that could be generated by a plant processing all of the estimated tonnage available (20,000 pounds of steam per hour*) would represent less than 20 percent of the facility's current steam requirements and less than 3 percent of the plant's rated capacity. Given that the potential impact that resource recovery could have on the energy requirements of the Holsten Plant is so modest and that the plant already enjoys relatively low-priced coal-derived energy, the base commander did not express any interest in this concept.

The two potential customers are described in greater detail in the subsections below.

Holliston Mills. A leading manufacturer of hard covers for textbooks and other bound volumes, Holliston Mills is located in the northeast portion of Hawkins County (its mailing address is in Kingsport, Sullivan County). Currently, the plant operates two shifts per day, 5 days per week.

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* Waste-derived steam estimates are based on an assumed 4,600 pounds of 125-psig steam per ton of solid waste.

Holliston uses gas-fired package boilers to produce low-pressure process steam and high-temperature hot water for bleaching and dyeing operations and for winter space-heating purposes. Typical process steam requirements are for 20,000 to 25,000 pounds per hour on an 8- to 12-hour-per-day basis.

The plant also uses substantial quantities of natural gas to fire the approximately 15 dryers that are used to dry the final products. These dryers typically operate 16 hours per day at temperatures ranging from $200^{o}F$ to $350^{o}F$. The dryers are equipped with solvent recovery equipment that is used to capture the volatile vapors for combustion prior to their release to the atmosphere.

Natural gas is purchased on an interruptible basis from the Hawkins County Natural Gas Utility District at a current price of $\$3.40/10^{6}$ Btu (tied to the price of No. 6 residual oil). Drying applications account for 60 percent of the natural gas used; process steam and hot water requirements account for the remainder.

The Holliston Mills plant engineer is familiar with the concept of energy recovery and has indicated that the company would be interested in purchasing competitively priced energy (either low-pressure steam or high-temperature gas). Moreover, it appears as though Holliston-owned land contiguous to the plant could be available for siting a resource recovery facility. In addition, the company would possibly consider partial equity investment in a project.

However, for Holliston Mills to be considered a viable potential energy customer, the company would have to modify its operations such that its energy requirements would be on a continuous, 24-hour basis. A resource recovery facility serving the Holliston plant at its current operating level (12 to 16 hours per day, depending on whether steam or hot gas were purchased) would have a low system load factor. While the Holliston Mills plant engineer did indicate that modifying plant operations to achieve a 24-hour-per-day status could be possible, in order for this to be considered, third-shift energy would have to be offered at a substantial discount to overcome the additional labor and other costs that would be incurred.

Holsten Army Ammunition Plant. HAAP is a government-owned contractor-operated munitions facility, comprising numerous buildings and covering several hundred acres. Most of the plant is located in Kingsport (Hawkins County); the remainder is located in neighboring Sullivan County.

HAAP's steam requirements are large. Two separate power plants, consisting of eight boilers, in total, each with a design capacity of 110,000 to 130,000 pounds of steam per hour, are used to produce low-pressure steam to meet manufacturing requirements. Six of these boilers are coal-fired; the other two, which are used as standby boilers, are gas-fired. Various manufacturing by-products are combusted in an environmental control boiler.

For the reasons previously stated, HAAP was eliminated as a potential energy customer.

Technical Analysis

Because the county only generates an estimated 62 TPD_5 of processible solid waste, a small-scale technology was determined to be the only technical option for producing either low-pressure steam or high-temperature gas for sale to Holliston Mills. For purposes of this assessment, a modular combustion system (MCU) was used as the small-scale reference technology.

MCU-based systems are operating successfully in a number of cities, including North Little Rock, Arkansas; and Salem, Virginia. These units, which are modular in design, can be grouped in numerous configurations to permit a waste processing design capacity ranging from less than 100 TPD to 300 TPD (individual unit sizes of 10 to 75 TPD). Within the 100-TPD to 300-TPD processing range, these MCU-based systems offer a cost advantage (in terms of cost per installed ton of capacity) over mass-burning waterwall or refractory-lined combustion technologies.

In the remainder of this section, a generic description is given of an MCU waste processing operation, followed by a preliminary system definition for both steam and high-temperature gas production.

Generic System Description. Whether the MCU-based resource recovery system were producing steam or high-temperature gas, the operation of the waste-processing subsystem would be similar. Figure 1 provides a simplified diagram of an MCU. As shown in this figure, waste is delivered to the resource recovery facility, onto a concrete loading floor. Unprocessible materials (e.g., large metal objects, water heaters, rugs) are removed and placed in residue containers for sale as scrap or for disposal in a landfill. A front-end loader is used to push the remaining solid waste into a hopper, and a hydraulic ram-feeder moves the waste into the incinerator's lower chamber where it is partially burned. The heat released provides the energy needed to dry and gasify the remaining waste. The carbon-monoxide-rich smoke leaves the top of the lower chamber and enters into the secondary chamber; there, more air is added, and the gases are burned to completion. As the hot gases exit the secondary chamber, they pass through a heat exchanger, where the heat in the exit gases is used to raise steam.* The stack gases are then discharged to the atmosphere.**

Ash consisting of glass, stone, metals, inert solid waste, and residual carbon char is moved from the bottom of the lower chamber into an ash disposal system. A magnet that recovers magnetic metals for sale to the secondary metal market can be installed. The remaining ash is loaded into a truck for disposal at a landfill.

Preliminary System Definitions. In the following paragraphs, initial system definitions are given for a resource recovery facility using Hawkins County waste only, to provide either low-pressure steam or high-temperature gas to Holliston Mills. Because of the preliminary nature of the waste and market data, these systems should be considered as illustrative only.

A 62-TPD_5 (72-TPD design capacity) MCU-based system would be used

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* When the energy form delivered is hot gas, rather than steam, an air-to-air heat exchanger (rather than a boiler) is used as the heat exchanger, or the heat exchanger is eliminated altogether and the buyer uses the hot gases directly.

** Particulate emission control is usually provided for in the design of the unit. However, increasingly stringent air pollution regulations will likely require the installation of electrostatic precipitators on MCUs.

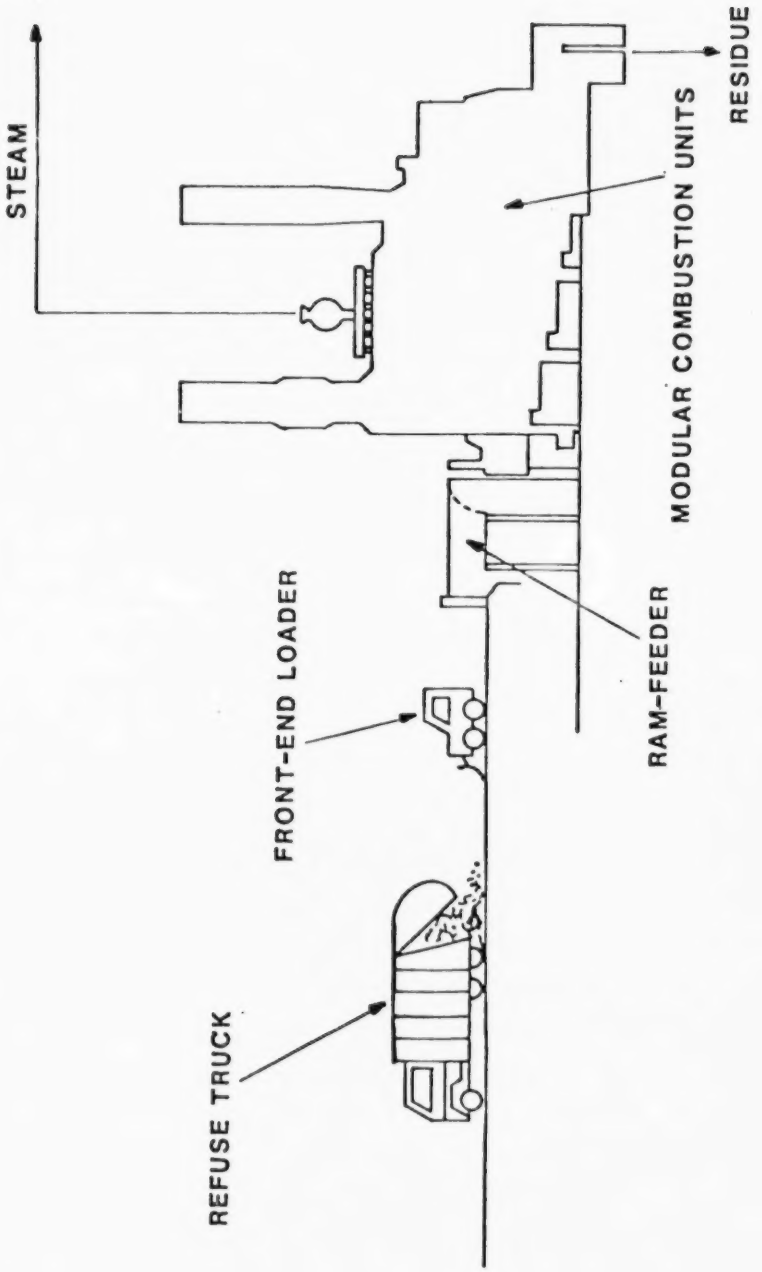

FIGURE 1
MODULAR COMBUSTION UNIT

to produce 125-psig steam for sale to Holliston Mills. In sizing this system, the following assumptions were used:

- The higher heating value (energy content) of the county's waste is 4,500 Btu per pound.
- System efficiency is 60 percent.
- Two 36-TPD units are used; each unit has a 90-percent availability, excluding scheduled maintenance.
- 125-psig steam is produced.
- Steam output is 4,600 pounds per ton of waste at 50°F inlet feedwater temperature with no condensate return.
- The system operates 24 hours per day, 5 days per week, 250 days per year.
- Annual average system throughput is 62 TPD_5, or 15,500 tons per year.
- Holliston Mills expands its operations to 24 hours per day (i.e., a third shift is added).

To provide steam to Holliston Mills, a steam transmission line would have to be constructed running from the resource recovery facility to the manufacturing plant.

When processing 62 TPD_5 of solid waste, the MCU-based plant would have an average hourly throughput of 11,900 pounds of steam, 24 hours per day. Holliston Mills' steam requirements range from 20,000 to 25,000 pounds per hour. The company would use in-house boilers to meet steam requirements in excess of the output of the resource recovery facility.

If high-temperature gas were produced for sale to Holliston Mills, a 62-TPD_5 (72 TPD design capacity) MCU-based system would be used. In sizing this system, the following assumptions were used:

- The higher heating value of the county's waste is 4,500 Btu per pound.
- An air-to-air heat exchanger is used such that system efficiency is 60 percent.
- Two 36-TPD units are used; each unit has a 90-percent availability, excluding scheduled maintenance.

- The system operates 24 hours a day, 5 days a week, 250 days a year.
- Annual average system throughput is 62 TPD_5, or 15,000 tons per year.
- Holliston Mills expands its operations to 24 hours per day (i.e., a third shift is added).

The system includes an air-to-air heat exchanger to avoid direct contact by the waste-derived hot gases with the book covers in the dryers. If, in field trials at the Holliston Mills plant, it was found that direct contact did not contaminate the product, the air-to-air heat exchanger could be eliminated and the products of combustion, suitably diluted to the required temperature, introduced directly into the dryers through injection ports. Direct venting would reduce system costs and could increase system efficiency from 60 percent to ±90 percent, depending on the distance that the hot gases had to be transported.

The MCU-based system would be located on Holliston-owned land contiguous to the manufacturing plant (preferably within a few hundred feet of the drying operations) to maximize energy efficiency.

The production of waste-derived hot gases in an MCU-based system with an air-to-air heat exchanger has been successfully demonstrated in an industrial application using industrial wastes (i.e., at the John Deere plant in Wisconsin). While use of an MCU-based system burning municipal waste to produce hot gases for sale has not been demonstrated, because the waste gases from municipal and industrial waste combustion are similar, no unusual problems are anticipated with this resource recovery option.

Economic Analysis

Preliminary economic estimates for a facility using Hawkins County waste only were developed for the MCU-based system producing low-pressure steam for sale to Holliston Mills. Because the economics for a plant selling high-temperature gas are expected to be similar, it was not necessary, at the prefeasibility level, to develop a separate set of estimates.

In developing the bond requirements estimate, it was assumed that the previously committed TVA grant financing of up to $1.2 million would be available to Hawkins County.* The bond requirements could conceivably be met either through the State of Tennessee Resource and Energy Facility Loan Program or through general obligation bonds (GOBs), industrial revenue bonds (IRBs), equity financing, or a combination of IRB and equity financing. Because of the lower interest rates available through the state loan program (similar to those associated with the GOB financing), this financing source was assumed in the preliminary economic analysis. (See Appendix A for a discussion of the state loan program.)

Even with the assumed availability of partial TVA funding and state loan program financing, the preliminary economic analysis indicates that a 62-TPD_5 (72-TPD design capacity) facility does not appear to be an economically competitive option. The projected net disposal cost in mid-1983 would be around $23 per ton, and in mid-1988, around $21 per ton for the resource recovery facility. Because this cost must be considered, to a certain extent, as incremental to the projected cost of a new landfill in 1983 (almost $12 per ton), the overall estimated solid waste disposal costs would likely be prohibitively high. Contributing to the high cost of this system is the fact that certain economies of scale are lost with a system of this size. For example, a 72-TPD (design capacity) system has the same staffing requirements as a 100-TPD system, and is nearly as costly to construct. In addition, because third-shift energy would have to be offered at a substantial discount as an incentive to Holliston Mills to extend its operations to 24 hours per day, energy revenues are lower than those that could be obtained from a company already operating 24 hours per day. In Appendix B, the economic and financing assumptions used and the economic estimates developed are presented in greater detail.

In developing these estimates, the following key assumptions were used:

- System capital costs escalate at a rate of 10 percent per year from current costs to the mid-point of construction, assumed to be mid-1982.

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* TVA has indicated that it would make grants available for resource recovery projects producing an energy product other than electricity. For this reason, cogeneration and straight electricity production from a resource recovery facility were not considered.

- A TVA grant of $1,200,000 is available to the project.
- State of Tennessee Resource and Energy Facility Loan Program financing is obtained (a 15-year bond issue at 9-percent interest per year).
- The 1983 value of natural gas is equivalent on an energy content basis to $0.93 per gallon of 1-percent-sulfur No. 6 oil.
- Energy costs escalate at 10 percent per year after 1983, and plant operations and maintenance costs escalate at 8 percent per year.
- During the first and second shifts, 95 percent of the steam produced is sold at a 10-percent discount.
- During the third shift, 90 percent of the steam produced is sold at a 25-percent discount.

RESOURCE RECOVERY AUGMENTED BY 30 TO 40 TPD_5 FROM A NEIGHBORING COUNTY

A plant sized to process Hawkins County waste alone, while apparently technically viable, did not appear to be economically competitive. Consequently, the economic feasibility of a 90-TPD_5 MCU-based system (supplemented by at least 30 TPD_5 from a neighboring county) was assessed. While it was beyond the scope of this study to identify possible sources of this additional waste, it was felt that preliminary economic analysis of this option was warranted to ascertain whether or not the county should consider pursuing an in-county project. Again, the availability of the previously committed TVA funding and financing under the state loan program were assumed in the economic analysis. In addition, it was assumed that the plant would service Holliston Mills (the only potential energy customer in the county), and that the company would extend its operations to 24 hours per day.

In this option, a 100-TPD (design capacity) MCU-based plant with an annual average throughput capacity of 90 TPD_5 would produce steam or hot gas for sale to Holliston Mills. In sizing this illustrative facility, the same assumptions used for the 62-TPD_5 MCU-based plant were applied, except that design capacity and waste throughput are obviously larger (two 50-TPD units would be used, rather than two 36-TPD units). In addition, if producing steam, this system would

have an average hourly steam output of 17,200 pounds (Holliston Mills currently uses 20,000 to 25,000 pounds of steam per hour).

The economic assessment indicated that a resource recovery plant at this size could be economically competitive with continued primary reliance on landfilling, assuming certain conditions can be met.* The net disposal cost is projected to be around $11 per ton in mid-1983, and $5 per ton in mid-1988. Appendix B contains a more detailed discussion of the economic projections. The key assumptions used in developing these estimates are the same as those described for a resource recovery project using Hawkins County waste only.

The preliminary economic feasibility depends, however, on the following:

- Obtaining at least an additional 30 to 40 TPD_5 (depending on the results of a more reliable estimate of the amount of processible waste available in Hawkins County) from a neighboring county.
- Obtaining previously committed grant financing from TVA of up to $1.2 million.
- Obtaining a commitment from Holliston Mills to extend its operation to 24 hours per day, at least 5 days per week, in response to third-shift energy priced at a substantial discount.
- Obtaining financing under the State of Tennessee Resource and Energy Facility Loan Program.

As discussed in greater detail in Appendix A, in order for a project to be eligible for funding under the state loan program, the energy revenues and the net disposal cost must be sufficient to support the project. Thus, while the bond issue is sold on the basis of public

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* For purposes of this study, it was assumed that the economics would be similar for a resource recovery plant producing either steam or high-temperature gas. Consequently, economic estimates were developed for a steam plant only. It is possible that the economics could prove to be better for a plant producing high-temperature gas. A detailed technical and economic analysis would be required to quantify the economic advantages of one system over the other.

ownership (as is a GOB) with the resultant low interest rates, the project must still meet the strict elegibility requirements typical of IRB financing (private-sector ownership).

The net disposal costs projected as part of this prefeasibility study for a 90-TPD_5 resource recovery facility are highly sensitive to several assumptions. First, if it was found that a discount for third-shift energy greater than the 25 percent assumed was required to motivate Holliston Mills to expand to 24-hours-per-day operations, the projected net disposal costs reported here would likely increase significantly. For example, if the third-shift discount were increased to 50 percent, the projected net disposal costs would increase by some $5 per ton of waste processed at the resource recovery facility. Second, the economics of the resource recovery facility are likely to improve for a larger facility. Thus, if Hawkins could obtain a sufficient tonnage of waste from a neighboring county to allow, for example, a 108-TPD_5 facility, the projected net disposal costs would likely be significantly lower than for a 90-TPD_5 facility, assuming a 25-percent discount for third-shift energy.

RESOURCE RECOVERY OUTSIDE OF HAWKINS COUNTY

Another option that the county might consider is participating in the implementation of a resource recovery facility in a neighboring county.* If such an option were to be pursued, the county would still have to proceed with the development of a new sanitary landfill, to be used for disposal of the estimated 78 TPD_5 of waste generated in the county until the resource recovery facility became operational. Once the county began hauling the processible portion of its waste (an estimated 62 TPD_5) to the resource recovery facility, the landfill could be converted to a rubbish dump to accommodate unprocessibles and emergency bypass waste. (Process residues would be disposed of in a landfill located in the other participating county.) A rubbish dump

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* A resource recovery project for Sullivan County, Tennessee/Washington County, Virginia, has reached the conceptual design phase. However, the hauling costs associated with transporting Hawkins County waste some 40 miles appear to prohibit the county's participation in this recovery project.

could presumably be operated at a lower cost than a full-scale landfill, such that Hawkins County could receive some landfill cost savings. In addition, the life of the new landfill would be extended greatly.

Again, were the county to investigate this option and decide to pursue it and if partial financing from the State of Tennessee loan program were desired, the same eligibility requirements as discussed in the previous section and in Appendix A would apply. The immediate next steps associated with this option are discussed in Chapter 4.

CHAPTER 4.
IMMEDIATE NEXT STEPS

The county has several solid waste management options it can pursue. These options are:

- Implement resource recovery. In this option, the county could implement a 90-TPD_5 Hawkins County resource recovery project that would also process from 30 to 40 TPD_5 of waste from a neighboring county to meet a portion of Holliston Mills' energy requirements. However, the feasibility of this option is contingent on several conditions being met. Alternatively, the county could investigate the possibility of participating in a joint resource recovery project to be located in a neighboring county and to service an energy customer(s) located in that county.

- Continue reliance on landfilling. In this option, the county can either (1) acquire a new sanitary landfill, or (2) arrange to haul Hawkins County waste to a landfill(s) located in a neighboring county.

In order for the county to select a preferred option, and, to determine whether, in fact, the preferred option can be implemented, certain next steps must be performed. These next steps, and the key issues associated with the various options, are discussed in the remainder of this chapter.

IMPLEMENT RESOURCE RECOVERY

The county could either elect to investigate further the feasibility of a 90 TPD_5 or large Hawkins County resource recovery project or to assess the possibility of a joint project to be located in a neighboring county. If the county chose to pursue either option, it would still have to acquire and develop a new landfill disposal site immediately.

Hawkins County Project

To confirm the feasibility of a 90-TPD_5 resource recovery project

servicing Holliston Mills, the following next steps should be performed:

- Hold discussions with Holliston Mills to ascertain its level of interest in a resource recovery project, particularly as regards its willingness to consider operating 24 hours a day in response to third-shift energy offered at a substantial discount. Obtain more detailed information on the company's energy practices and requirements, including detailed energy load profiles showing hourly, daily, and seasonal variations; aggregate current and projected fuel costs; and electrical, water, and other utility charges.

- Establish a waste characterization program in Hawkins County to ascertain that a sufficient amount of solid waste with a sufficient energy value is available to satisfy the requirements of the potential energy customer. In addition, determine the seasonal fluctuations in waste quantity and composition.

- After developing a more refined estimate of the processible tonnage generated in Hawkins County, establish the feasibility of securing additional tonnage from a neighboring county, such that a waste processing capacity of at least 90 TPD_5 could be achieved. A system sized to process more than 90 TPD_5 could be viable, assuming the necessary additional tonnage could be obtained.* The economics are likely to be more favorable for a larger size facility.

- Determine whether Hawkins County and the participating neighboring county control the various portions of the waste stream generated within the respective counties; develop strategies to ensure that the waste can be directed to a resource recovery facility.

If these tasks confirm the feasibility of the Hawkins County project, a prefeasibility study should be submitted to the State of Tennessee as part of an application under the Resource and Energy Facility Loan Program. To be considered for financing in 1981, the feasibility study would have to be submitted by January 15, 1981. In addition, as the economic feasibility of this project is dependent upon the receipt of the previously committed TVA financing, the county would have to obtain a firm commitment for this financing prior to applying for a state grant.

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* The maximum size of the resource recovery facility would be defined by the product requirements of Holliston Mills and the amount of additional waste available from a neighboring community.

When considering this option, the county should keep in mind the following. If this project were implemented in mid-1983 (the assumed first year of resource recovery facility commercial operations), at that time, the county could convert the new landfill for use as a rubbish, process residue, and emergency bypass waste disposal facility. The reduced volume to be handled at the landfill should result in some cost savings. Nonetheless, the cost of resource recovery should be considered, to some extent, as incremental to the cost of the landfill. Other benefits that will accrue to the county, should it pursue the implementation of an in-county resource recovery facility, are:

- The life of the new landfill will be extended significantly.
- The county will be contributing to national alternative energy goals.
- Resource recovery is an environmentally sound alternative to continued reliance on landfill disposal as a primary means of solid waste management.

Furthermore, should the county decide to use low-priced alternative energy for a resource recovery facility as an incentive to attract industrial development, the capacity of the MCU-based system can be increased by adding additional 50-TPD units. In this case, the county would likely have to obtain additional waste from neighboring counties to support a larger facility.

Joint Project Located in Neighboring County

Because of the uncertainties associated with the 90-TPD_5 project in Hawkins County (e.g., whether Holliston Mills will extend its operation to 24 hours), the county should concurrently investigate the feasibility of implementing a joint project in a neighboring county. Again, this option requires that the county immediately acquire and develop a new county landfill.

If Hawkins County is interested in this approach to resource recovery, it should hold discussions with neighboring counties to ascertain their level of interest in participating in a resource

recovery facility. If these discussions indicate interest on the part of a neighboring county(ies), a prefeasibility study should be performed (presumably as a joint endeavor by the counties) to ascertain that the necessary ingredients to resource recovery exist; namely, an economically viable match is possible among waste supply, energy markets, sites, and available technologies.

If the results of the prefeasibility study are positive, the counties should proceed to:

- Hold discussions with the energy customer(s) to obtain information on level of interest and energy requirements as described in the previous section.
- Establish a weighing and sorting program in both counties to refine waste generation and quality estimates.
- Determine that sufficient control over the waste stream exists to ensure delivery of waste to the resource recovery facility.

Again, if the counties were to pursue State of Tennessee funding, the program's eligibility criteria would have to be met.

In considering this option, the county should be aware that, once the resource recovery facility was operating, the new Hawkins County landfill could be converted to a rubbish dump to handle unprocessibles and emergency bypass waste. This could result in some cost savings and would extend the usable life of the new landfill significantly. However, the county would also have to take into consideration the costs associated with developing a transfer station (presumably located at the site of the new landfill) where removal of a large portion of the unprocessible waste would occur prior to hauling the waste to the resource recovery facility. Recent work performed in other areas of the county indicates that Hawkins County can expect to pay between $5 and $12 per ton in haul and transfer costs, depending on the distance to be traveled.

Again, the same benefits that would accrue to the county were it to implement an in-county resource recovery project would be applicable in this case.

CONTINUE RELIANCE ON LANDFILLING

If the county decides to continue its reliance on landfilling as a means of solid waste disposal, the county should immediately:

- Acquire and develop a new site for a sanitary solid waste landfill, or
- Investigate the possibility of disposing of its solid waste in a landfill(s) in a neighboring community.

Obviously, should the county elect to pursue landfill disposal outside of the county, the associated haul cost would be a major constraint to any otherwise viable landfill disposal possibilities.

It should be noted that, were the county to develop a new sanitary landfill and make a subsequent decision to pursue resource recovery, the volume of waste to be landfilled could be reduced by 75 percent, depending on whether the resource recovery facility were located in a neighboring county or in Hawkins County. This volume reduction would likely have associated cost savings, and would extend the life of the new landfill significantly.

APPENDIX A.
STATE OF TENNESSEE RESOURCE AND ENERGY FACILITY LOAN PROGRAM

In this appendix, the main features and requirements of the State of Tennessee Resource and Energy Facility Loan Program are summarized.

The state loan program is used to finance facilities that recover energy or materials from municipal solid waste. As such, it may be appropriate for financing a Hawkins County project.

The loan program incorporates aspects of both GOB and IRB financing. The state issues bonds and then loans the bond proceeds to the sponsor of an eligible project. The bonds, which are issued and sold by the state (i.e., the state acts as bond underwriter), enjoy tax-exempt status, as well as, the full faith and credit backing of the state. In order for a project to be considered for financing under the program, it must have demonstrated economic and technical merit. Thus, while the bond issue is sold on the basis of a GOB, with the resultant low interest rates, in essence the project must meet the strict credibility guidelines typical of IRB-type financing.

ELIGIBILITY

Several project eligibility criteria have to be met. First, at least 60 percent of the materials or energy content of the municipal solid waste stream has to be recovered and sold. Second, 50 percent or more of this quantity of materials or energy has to be spoken for by at least a letter of intent from prospective customers. Third, facilities that will convert the municipal solid waste must be owned by public-sector entities (i.e., a municipality, a regional entity, or a solid waste authority). Fourth, prior to receiving initial commitment as to loan availability, a prefeasibility study must be submitted that demonstrates the technical and economic merit

of the project. Once initial commitment is made by the Tennessee state program and prior to bond proceeds being received, a more detailed feasibility analysis is required (similar to that required by an investment banking firm for similar type projects). The pre-feasibility study indicating initial technical and economic merit must be submitted to the Tennessee State Department of Public Health by January 15 of the year in which the proceeds are being requested.

KEY FEATURES

Interest rates are likely to be similar to those associated with GOB financing. However, because of the uncertainties in the marketplace at the present time, it is not possible to estimate what the interest rate may be.

Bond issue is predicated under a sinking-fund-type of arrangement with the term of the bond issue not to exceed the expected useful life of a facility. For an MCU-based system, the assumed useful life is around 15 years.

Given the uncertainty associated with the capital cost projections for any resource recovery project, inclusion of a contingency fund is strongly recommended.

Interest payments during construction and startup are similar to GOB or IRB financing, and are to be capitalized and incorporated into the bond issue. It appears that a debt service reserve fund is not necessary.

While the project must be owned by a public-sector entity, there appears to be flexibility regarding operation; if appropriate, it appears that a facility could be operated by a private-sector firm under contract to the public-sector owner.

APPENDIX B.
ECONOMIC AND FINANCING
ASSUMPTIONS AND PROJECTIONS

In this appendix, the assumptions used and the projections made in the preliminary economic analysis are used. The economic and financing assumptions are given in Table B-1. Tables B-2 and B-3 give the capital and operating and maintenance cost and revenue estimates for the 100-TPD MCU system. Similar information is provided in Tables B-4 and B-5 for the smaller 72-TPD MCU system. Finally, estimated labor requirements for a 100-TPD MCU system are given in Table B-6.

TABLE B-1

ECONOMIC AND FINANCING ASSUMPTIONS

- 1983 system capital costs based on turnkey or full-service procurement and escalated from current prices at 10 percent per year to the mid-point of construction.
- Energy revenues predicated on:
  - 1983 value of natural gas equivalent to $0.93/gallon 1-percent-sulfur No. 6 oil; cost of energy escalates at 10 percent per year after 1983.
  - 95 percent of steam produced during first and second shifts sold at 10-percent discount.
  - 90 percent of steam produced during third shift sold at 25-percent discount.
- Operation and maintenance costs escalate at 8 percent per year from current costs.
- TVA grant of $1.2 million is available.
- Interest earned on construction funds prior to disbursement and on contingency reserve funds exceeds interest payments to bondholders during construction and startup phases.
- Bond requirements predicated on State of Tennessee Resource and Energy Facility Loan Program financing; 15-year bond issue at 9-percent interest per year.

TABLE B-2

PROJECTED MID-1983 CAPITAL COSTS FOR

100-TPD MCU SYSTEM

(90-TPD_5 AVERAGE THROUGHPUT)

SYSTEM CAPITAL COSTS[1]	$ 3,550,000
CONTINGENCY (15%)	535,000
ENGINEERING/LEGAL	100,000
SUBTOTAL:	$ 4,185,000
LESS TVA GRANT[2]	($1,200,000)
CAPITALIZED INTEREST[3] DURING CONSTRUCTION AND STARTUP	-0-
BOND REQUIREMENTS[4]	$ 2,985,000
TOTAL FINANCING REQUIREMENTS:	$ 4,185,000

1. 1983 system capital costs based on turnkey or full-service procurement and 10-percent annual escalation to mid-point of construction.
2. TVA grant of $1.2 million assumed to be available.
3. Interest earned on construction funds prior to disbursement and on contingency reserve funds exceeds interest payments to bondholders during construction and startup phases. This situation, which is atypical of most resource recovery projects being financed today, occurs because of the availability of the TVA grant monies.
4. Bond requirements predicated upon State of Tennessee Resource and Energy Facility Loan Program financing; 15-year bond issue at 9-percent interest per year.

TABLE B-3

PROJECTED 1983 AND 1988 ECONOMICS FOR

100-TPD MCU SYSTEM

(90-TPD_5 AVERAGE THROUGHPUT)

ANNUAL SOLID WASTE THROUGHPUT (tons)		22,500
ANNUAL ENERGY PRODUCTION (lbs of steam)		103,410,000
OPERATION COST ELEMENTS	1ST YEAR (mid-1983)	6TH YEAR (mid-1988)
Labor	$244,000	$358,500
Maintenance and Replacements	232,500	342,000
Utilities	50,000	73,000
Residual Disposal*	NA	NA
Taxes	NA	NA
Insurance	75,000	110,000
Operator Profit	50,000	73,000
TOTAL OPERATING COSTS	$651,500	$956,500
ANNUAL DEBT SERVICE EXPENSES	$370,000	$370,000
ENERGY REVENUES	($734,000)	($1,182,000)
INTEREST INCOME	($40,000)	($40,000)
NET DISPOSAL COSTS	$247,500	$104,500
NET DISPOSAL COSTS (per ton)	$11.00	$4.64

* The cost of residual disposal has been reflected in the projected cost of landfill disposal.

TABLE B-4

PROJECTED-MID 1983 CAPITAL COSTS FOR

72-TPD MCU SYSTEM

(62-TPD_5 AVERAGE THROUGHPUT)

SYSTEM CAPITAL COSTS[1]	$ 3,060,000
CONTINGENCY (15%)	460,000
ENGINEERING/LEGAL	100,000
SUBTOTAL:	$ 3,620,000
LESS TVA GRANT[2]	($ 1,200,000)
CAPITALIZED INTEREST[3] DURING CONSTRUCTION AND STARTUP	-0-
BOND REQUIREMENTS[4]	$ 2,420,000
TOTAL FINANCING REQUIREMENTS:	$ 3,620,000

1. 1983 system capital costs based on turnkey or full-service procurement and 10-percent annual escalation to mid-point of construction.
2. TVA grant of $1.2 million assumed to be available.
3. Interest earned on construction funds prior to disbursement and on contingency reserve funds exceeds interest payments to bondholders during construction and startup phases. This situation, which is atypical of most resource recovery projects being financed today, occurs because of the availability of the TVA grant monies.
4. Bond requirements predicated upon State of Tennessee Resource and Energy Facility Loan Program financing; 15-year bond issue at 9-percent interest per year.

TABLE B-5

PROJECTED 1983 AND 1988 ECONOMICS FOR

72-TPD MCU SYSTEM

(62-TPD$_5$ AVERAGE THROUGHPUT)

ANNUAL SOLID WASTE THROUGHPUT (tons)		15,600
ANNUAL ENERGY PRODUCTION (lbs of steam)		71,698,000
OPERATION COST ELEMENTS	1ST YEAR (mid-1983)	6TH YEAR (mid-1988)
Labor	$244,000	$358,500
Maintenance and Replacements	176,000	259,000
Utilities	39,000	57,000
Residual Disposal*	NA	NA
Taxes	NA	NA
Insurance	65,000	96,000
Operator Profit	39,000	57,000
TOTAL OPERATING COSTS	$563,000	$827,500
ANNUAL DEBT SERVICE EXPENSES	$300,000	$300,000
ENERGY REVENUES	($474,000)	($764,000)
INTEREST INCOME	($32,000)	($32,000)
NET DISPOSAL COSTS	$357,000	$331,000
NET DISPOSAL COSTS (per ton)	$22.88	$21.22

* The cost of residual disposal has been reflected in the projected cost of landfill disposal.

TABLE B-6

ESTIMATED LABOR REQUIREMENTS FOR

100-TPD MCU SYSTEM

Position	Number of Employees	Employee Salary*	Subtotal
Plant Manager	1	$25,000	$ 25,000
Scale Operator/Clerk	1	13,500	13,500
Operators	3	16,000	48,000
Shift Managers	4	13,500	54,000
Ash Truck Driver	1	13,500	13,500
Maintenance Mechanic	1	19,000	19,000
Electrician**	1/2	15,000	15,000
TOTAL EMPLOYEES	11 1/2		
DIRECT LABOR EXPENSES			$188,000
FRINGE BENEFITS (@ 30%)			56,000
TOTAL LABOR EXPENSES:			$244,000

* 1983 dollars.

** Contract employee.